

Remarks

The Office Action mailed July 23, 2007, and made final, has been carefully reviewed and the following remarks have been made in consequence thereof.

Claims 1-20 are now pending in this application. Claims 9, 10, and 15-18 are allowed. Claims 1-8, 11-14, 19, and 20 stand rejected.

Claims 9, 10, and 15-18 have been indicated as being allowed. Applicant thanks the Examiner for the allowance of Claims 9, 10, and 15-18.

The rejection of Claims 1-3, 6-8, 14, 19, and 20 under 35 U.S.C. § 102(b) as being anticipated by Muzilla et al. (U.S. Pat. No. 5,908,391) ("Muzilla") is respectfully traversed.

Muzilla describes an ultrasound imaging system for increasing spatial resolution and sensitivity of a color flow image. The system uses a plurality of transmit focal zones and a low f-number to enable tight focusing over a large depth-of-field. The focal zones are each at a respective depth with respect to a beamformer, and each focal zone is fired on a separate acoustic frame. An acoustic frame is defined as a set of vertical vectors fired from left to right to form a single two-dimensional set of pixel data. Accordingly, each acoustic frame is spaced apart with respect to an axis along which the waveforms are transmitted. As such, the frames are spaced apart along a direction that is parallel to the direction along which waveforms are transmitted.

Muzilla further describes that the frames are averaged to reduce frame-to-frame flicker by using a frame averaging algorithm. A persistence coefficient is selected (26) and an unfiltered frame (X_n) is compared to an adjacent filtered frame (Y_{n-1}) using the algorithm and coefficient. Frame-averaged current pixel data is displayed. Notably, Muzilla does not describe nor suggest interleaving ultrasonic pulse transmissions for acquiring acoustic line signals of a first frame between ultrasonic pulse transmissions for acquiring acoustic line signals of a second frame.

Claim 1 recites an ultrasonic pulse transmission method comprising "defining a plurality of frames wherein each of the plurality of frames is spaced from an

adjacent frame of the plurality of frames with respect to a first direction, wherein the first direction is non-parallel to a second direction along which ultrasonic pulse transmission are conducted; and when P ultrasonic pulse transmissions are conducted in the second direction to acquire a first acoustic line signal that belongs to a first frame of the plurality of frames, interleaving, between the P ultrasonic pulse transmissions conducted in the second direction, at least one ultrasonic pulse transmission for acquiring a second acoustic line signal that belongs to a second frame of the plurality of frames that is different from the first frame.”

Muzilla does not describe nor suggest an ultrasonic pulse transmission method as is recited in Claim 1. More specifically, Muzilla does not describe nor suggest a method that includes defining a plurality of frames such that each of the plurality of frames is spaced from an adjacent frame of the plurality of frames with respect to a first direction, wherein the first direction is non-parallel to a second direction along which ultrasonic pulse transmission are conducted. Rather, Muzilla describes shifting a transmit focal zone within the region of interest to define acoustic frames that are spaced apart in a direction that is parallel to a direction of waveform transmission.

Furthermore, Muzilla does not describe nor suggest a method that includes, when P ultrasonic pulse transmissions are conducted in a second direction to acquire a first acoustic line signal that belongs to a first frame of a plurality of frames, interleaving, between the P ultrasonic pulse transmissions conducted in the second direction, at least one ultrasonic pulse transmission for acquiring a second acoustic line signal that belongs to a second frame of the plurality of frames that is different from the first frame. Rather, Muzilla describes averaging the frames in which the focus is shifted and displaying an averaged frame. The averaging of frames in Muzilla is not a description nor a suggestion of interleaving, between P ultrasonic pulse transmissions conducted in a second direction to acquire a first acoustic line signal that belongs to a first frame, at least one ultrasonic pulse transmission for acquiring a second acoustic line signal that belongs to a second frame that is different from the first frame.

Accordingly, for the reasons set forth above, Claim 1 is submitted to be patentable over Muzilla.

Claims 2, 3, 6, and 19 depend from independent Claim 1. When the recitations of Claims 2, 3, 6, and 19 are considered in combination with the recitations of Claim 1, Applicant submits that dependent Claims 2, 3, 6, and 19 likewise are patentable over Muzilla.

Claim 7 recites an ultrasonic diagnostic apparatus comprising “an ultrasonic probe; a number-of-frames defining device for defining a plurality of frames, wherein each frame of the plurality of frames is spaced from an adjacent frame of the plurality of frames with respect to a first direction, wherein the first direction is non-parallel to a second direction along which ultrasonic transmissions are driven; a transmitting/receiving device for driving said ultrasonic probe to conduct P ultrasonic pulse transmissions in the second direction and receive echoes to acquire a first acoustic line signal that belongs to a first frame of the plurality of frames, wherein P is at least equal to two; and a transmission direction control device configured to control the transmission direction to interleave, between the P ultrasonic pulse transmissions conducted in the second direction to acquire the first acoustic line signal, at least one ultrasonic pulse transmission to acquire a second acoustic line signal that belongs to a second frame of the plurality frames that is different from the first frame.”

Muzilla does not describe nor suggest an ultrasonic diagnostic apparatus as is recited in Claim 7. More specifically, Muzilla does not describe nor suggest an ultrasonic diagnostic apparatus that includes a number-of-frames defining device for defining a plurality of frames, wherein each frame of the plurality of frames is spaced from an adjacent frame of the plurality of frames with respect to a first direction, wherein the first direction is non-parallel to a second direction along which ultrasonic transmissions are driven. Rather, Muzilla describes shifting a transmit focal zone within the region of interest to define acoustic frames that are spaced apart in a direction that is parallel to a direction of waveform transmission.

Furthermore, Muzilla does not describe nor suggest an ultrasonic diagnostic apparatus that includes a transmission direction control device configured to control the transmission direction to interleave, between P ultrasonic pulse transmissions conducted in a second direction to acquire a first acoustic line signal that belongs to a

first frame of a plurality of frames, at least one ultrasonic pulse transmission to acquire a second acoustic line signal that belongs to a second frame of the plurality frames that is different from the first frame. Rather, Muzilla describes averaging the frames in which the focus is shifted and displaying an averaged frame. The averaging of frames in Muzilla is not a description nor a suggestion of interleaving, between P ultrasonic pulse transmissions conducted in a second direction to acquire a first acoustic line signal that belongs to a first frame, at least one ultrasonic pulse transmission for acquiring a second acoustic line signal that belongs to a second frame that is different from the first frame.

Accordingly, for the reasons set forth above, Claim 7 is submitted to be patentable over Muzilla.

Claims 8, 14, and 20 depend from independent Claim 7. When the recitations of Claims 8, 14, and 20 are considered in combination with the recitations of Claim 7, Applicant submits that dependent Claims 8, 14, and 20 likewise are patentable over Muzilla.

For at least the reasons set forth above, Applicant respectfully requests that the Section 102 rejection of Claims 1-3, 6-8, 14, 19, and 20 be withdrawn.

The rejection of Claims 4, 11, and 12 under 35 U.S.C. § 103(a) as being unpatentable over Muzilla in view of Mochizuki et al (U.S. Pat. No. 5,152,294) ("Mochizuki") is respectfully traversed.

Muzilla is described above. Mochizuki describes an ultrasonic transducer (28) coupled to a swing mechanism (26) within a scanner case (22) such that the ultrasonic transducer (28) may be rotated in a direction normal to an arrangement direction of an array (30) of transducer elements (30a). Swinging a two-dimensional acquisition plane (S) of the transducer (28) normal to the arrangement direction of the array transducer (30) enables a three-dimensional data acquisition area (V) to be scanned. Mochizuki further describes that ultrasonic scanners transmit ultrasonic beams, receive reflected echoes, and display a cross-sectional image layer of a scanned object based on the received echoes.

Applicant respectfully traverses the assertion beginning on page 3 of the Office Action that “[i]n a trivial sense then, if the entire process of Muzilla et al were repeated across successive orthogonal increments to assembly a 3-D volume, then the acoustic line signals associated with the adaptively averaged frames of each scan direction would inherently belong to different spatial frames since mathematical and electronic scanning in the orthogonal direction are well-known for purposes of assembling a 3-D volume, the same interpretation regarding acoustic line signal-frame associations would apply to performing the orthogonal [*sic*] component of a 3-D scan electronically.” Rather, in contrast, Applicant respectfully submits that it is not inherent in either Muzilla or Mochizuki that acoustic line signals associated with adaptively averaged frames of each scan direction would belong to different spatial frames. For example, by shifting the focal zone of a waveform, as described in Muzilla, acoustic line signals transmitted in different directions may belong to the same spatial frame.

Accordingly, neither Muzilla nor Mochizuki, considered alone or in combination, describes or suggests electronically changing the ultrasonic pulse transmission direction among acoustic line signals that belong to a same frame of a plurality of frames, and mechanically changing the ultrasonic pulse transmission direction among acoustic line signals that belong to different frames of the plurality of frames, as is recited in Claims 4 and 12. Furthermore, neither Muzilla nor Mochizuki, considered alone or in combination, describes or suggests electronically changing the ultrasonic pulse transmission direction among acoustic line signals that belong to the same frame of a plurality of frames, and also electronically changing the ultrasonic pulse transmission direction among acoustic line signals that belong to different frames of the plurality of frames, as is recited in Claim 11.

Moreover, Claim 4 depends from independent Claim 1, which recites an ultrasonic pulse transmission method comprising “defining a plurality of frames wherein each of the plurality of frames is spaced from an adjacent frame of the plurality of frames with respect to a first direction, wherein the first direction is non-parallel to a second direction along which ultrasonic pulse transmission are conducted; and when P ultrasonic pulse transmissions are conducted in the second direction to acquire a first acoustic line signal that belongs to a first frame of the

plurality of frames, interleaving, between the P ultrasonic pulse transmissions conducted in the second direction, at least one ultrasonic pulse transmission for acquiring a second acoustic line signal that belongs to a second frame of the plurality of frames that is different from the first frame.”

Neither Muzilla nor Mochizuki, considered alone or in combination, describes or suggests an ultrasonic pulse transmission method as is recited in Claim 1. More specifically, neither Muzilla nor Mochizuki, considered alone or in combination, describes or suggests a method that includes defining a plurality of frames such that each of the plurality of frames is spaced from an adjacent frame of the plurality of frames with respect to a first direction, wherein the first direction is non-parallel to a second direction along which ultrasonic pulse transmission are conducted. Rather, Muzilla describes shifting a transmit focal zone within the region of interest to define acoustic frames that are spaced apart in a direction that is parallel to a direction of waveform transmission, and Mochizuki describes a mechanism of a mechanical four-dimensional probe.

Furthermore, neither Muzilla nor Mochizuki, considered alone or in combination, describes or suggests a method that includes, when P ultrasonic pulse transmissions are conducted in a second direction to acquire a first acoustic line signal that belongs to a first frame of a plurality of frames, interleaving, between the P ultrasonic pulse transmissions conducted in the second direction, at least one ultrasonic pulse transmission for acquiring a second acoustic line signal that belongs to a second frame of the plurality of frames that is different from the first frame. Rather, Muzilla describes averaging the frames in which the focus is shifted and displaying an averaged frame, and Mochizuki describes a mechanism of a mechanical four-dimensional probe. The averaging of frames in Muzilla is not a description nor a suggestion of interleaving, between P ultrasonic pulse transmissions conducted in a second direction to acquire a first acoustic line signal that belongs to a first frame, at least one ultrasonic pulse transmission for acquiring a second acoustic line signal that belongs to a second frame that is different from the first frame.

Accordingly, for the reasons set forth above, Claim 1 is submitted to be patentable over Muzilla in view of Mochizuki.

When the recitations of Claim 4 are considered in combination with the recitations of Claim 1, Applicant submits that dependent Claim 4 likewise is patentable over Muzilla in view of Mochizuki.

Claims 11 and 12 depend from independent Claim 7, which recites an ultrasonic diagnostic apparatus comprising "an ultrasonic probe; a number-of-frames defining device for defining a plurality of frames, wherein each frame of the plurality of frames is spaced from an adjacent frame of the plurality of frames with respect to a first direction, wherein the first direction is non-parallel to a second direction along which ultrasonic transmissions are driven; a transmitting/receiving device for driving said ultrasonic probe to conduct P ultrasonic pulse transmissions in the second direction and receive echoes to acquire a first acoustic line signal that belongs to a first frame of the plurality of frames, wherein P is at least equal to two; and a transmission direction control device configured to control the transmission direction to interleave, between the P ultrasonic pulse transmissions conducted in the second direction to acquire the first acoustic line signal, at least one ultrasonic pulse transmission to acquire a second acoustic line signal that belongs to a second frame of the plurality frames that is different from the first frame."

Neither Muzilla nor Mochizuki, considered alone or in combination, describes or suggests an ultrasonic diagnostic apparatus as is recited in Claim 7. More specifically, neither Muzilla nor Mochizuki, considered alone or in combination, describes or suggests an ultrasonic diagnostic apparatus that includes a number-of-frames defining device for defining a plurality of frames, wherein each frame of the plurality of frames is spaced from an adjacent frame of the plurality of frames with respect to a first direction, wherein the first direction is non-parallel to a second direction along which ultrasonic transmissions are driven. Rather, Muzilla describes shifting a transmit focal zone within the region of interest to define acoustic frames that are spaced apart in a direction that is parallel to a direction of waveform transmission, and Mochizuki describes a mechanism of a mechanical four-dimensional probe.

Furthermore, neither Muzilla nor Mochizuki, considered alone or in combination, describes or suggests an ultrasonic diagnostic apparatus that includes a

transmission direction control device configured to control the transmission direction to interleave, between P ultrasonic pulse transmissions conducted in a second direction to acquire a first acoustic line signal that belongs to a first frame of a plurality of frames, at least one ultrasonic pulse transmission to acquire a second acoustic line signal that belongs to a second frame of the plurality frames that is different from the first frame. Rather, Muzilla describes averaging the frames in which the focus is shifted and displaying an averaged frame, and Mochizuki describes a mechanism of a mechanical four-dimensional probe. The averaging of frames in Muzilla is not a description nor a suggestion of interleaving, between P ultrasonic pulse transmissions conducted in a second direction to acquire a first acoustic line signal that belongs to a first frame, at least one ultrasonic pulse transmission for acquiring a second acoustic line signal that belongs to a second frame that is different from the first frame.

Accordingly, for the reasons set forth above, Claim 7 is submitted to be patentable over Muzilla in view of Mochizuki.

When the recitations of Claims 11 and 12 are considered in combination with the recitations of Claim 7, Applicant submits that dependent Claims 11 and 12 likewise are patentable over Muzilla in view of Mochizuki.

For at least the reasons set forth above, Applicant respectfully requests that the Section 103 rejection of Claims 4, 11, and 12 be withdrawn.

The rejection of Claims 5 and 13 under 35 U.S.C. § 103(a) as being unpatentable over Muzilla in view of Dubberstein et al (U.S. Pat. No. 6,159,153) ("Dubberstein") is respectfully traversed.

Initially, Applicant notes that although on page 4 of the Office Action the Examiner rejects Claim 14 as being unpatentable over Muzilla in view of Dubberstein, it appears from the reasons for rejection that Claim 13, rather than Claim 14, is being rejected. Accordingly, Applicant proceeds as if Claim 13 is rejected as being unpatentable over Muzilla in view of Dubberstein and treats the rejection of Claim 14 as a typographical error.

Muzilla is described above. Dubberstein describes an ultrasound transducer (120) that transmits a plurality of ultrasound beams (130 and 130b) in a plurality of transmit directions and at a plurality of transmit frequencies to reduce interference between two ultrasound beams (130 and 130b) such that a frame rate may be increased.

Claim 5 depends from independent Claim 1, which recites an ultrasonic pulse transmission method comprising “defining a plurality of frames wherein each of the plurality of frames is spaced from an adjacent frame of the plurality of frames with respect to a first direction, wherein the first direction is non-parallel to a second direction along which ultrasonic pulse transmission are conducted; and when P ultrasonic pulse transmissions are conducted in the second direction to acquire a first acoustic line signal that belongs to a first frame of the plurality of frames, interleaving, between the P ultrasonic pulse transmissions conducted in the second direction, at least one ultrasonic pulse transmission for acquiring a second acoustic line signal that belongs to a second frame of the plurality of frames that is different from the first frame.”

Neither Muzilla nor Dubberstein, considered alone or in combination, describes or suggests an ultrasonic pulse transmission method as is recited in Claim 1. More specifically, neither Muzilla nor Dubberstein, considered alone or in combination, describes or suggests a method that includes defining a plurality of frames wherein each of the plurality of frames is spaced from an adjacent frame of the plurality of frames with respect to a first direction, wherein the first direction is non-parallel to a second direction along which ultrasonic pulse transmission are conducted. Rather, Muzilla describes shifting a transmit focal zone within the region of interest to define acoustic frames that are spaced apart in a direction that is parallel to a direction of waveform transmission, and Dubberstein describes an ultrasound transducer that transmits a plurality of ultrasound beams in a plurality of transmission directions and frequencies.

Furthermore, neither Muzilla nor Dubberstein, considered alone or in combination, describes or suggests a method that includes, when P ultrasonic pulse transmissions are conducted in a second direction to acquire a first acoustic line signal

that belongs to a first frame of a plurality of frames, interleaving, between the P ultrasonic pulse transmissions conducted in the second direction, at least one ultrasonic pulse transmission for acquiring a second acoustic line signal that belongs to a second frame of the plurality of frames that is different from the first frame. Rather, Muzilla describes averaging the frames in which the focus is shifted and displaying an averaged frame, and Dubberstein describes an ultrasound transducer that transmits a plurality of ultrasound beams in a plurality of transmission directions and frequencies. The averaging of frames in Muzilla is not a description nor a suggestion of interleaving, between P ultrasonic pulse transmissions conducted in a second direction to acquire a first acoustic line signal that belongs to a first frame, at least one ultrasonic pulse transmission for acquiring a second acoustic line signal that belongs to a second frame that is different from the first frame.

Accordingly, for the reasons set forth above, Claim 1 is submitted to be patentable over Muzilla in view of Dubberstein.

When the recitations of Claim 5 are considered in combination with the recitations of Claim 1, Applicant submits that dependent Claim 5 likewise is patentable over Muzilla in view of Dubberstein.

Claim 13 depends from independent Claim 7, which recites an ultrasonic diagnostic apparatus comprising "an ultrasonic probe; a number-of-frames defining device for defining a plurality of frames, wherein each frame of the plurality of frames is spaced from an adjacent frame of the plurality of frames with respect to a first direction, wherein the first direction is non-parallel to a second direction along which ultrasonic transmissions are driven; a transmitting/receiving device for driving said ultrasonic probe to conduct P ultrasonic pulse transmissions in the second direction and receive echoes to acquire a first acoustic line signal that belongs to a first frame of the plurality of frames, wherein P is at least equal to two; and a transmission direction control device configured to control the transmission direction to interleave, between the P ultrasonic pulse transmissions conducted in the second direction to acquire the first acoustic line signal, at least one ultrasonic pulse transmission to acquire a second acoustic line signal that belongs to a second frame of the plurality frames that is different from the first frame."

Neither Muzilla nor Dubberstein, considered alone or in combination, describes or suggests an ultrasonic diagnostic apparatus as is recited in Claim 7. Specifically, neither Muzilla nor Dubberstein, considered alone or in combination, describes or suggests an ultrasonic diagnostic apparatus that includes a number-of-frames defining device for defining a plurality of frames, wherein each frame of the plurality of frames is spaced from an adjacent frame of the plurality of frames with respect to a first direction, wherein the first direction is non-parallel to a second direction along which ultrasonic transmissions are driven. Rather, Muzilla describes shifting a transmit focal zone within the region of interest to define acoustic frames that are spaced apart in a direction that is parallel to a direction of waveform transmission, and Dubberstein describes an ultrasound transducer that transmits a plurality of ultrasound beams in a plurality of transmission directions and frequencies.

Furthermore, neither Muzilla nor Dubberstein, considered alone or in combination, describes or suggests an ultrasonic diagnostic apparatus that includes a transmission direction control device configured to control the transmission direction to interleave, between P ultrasonic pulse transmissions conducted in a second direction to acquire a first acoustic line signal that belongs to a first frame of a plurality of frames, at least one ultrasonic pulse transmission to acquire a second acoustic line signal that belongs to a second frame of the plurality frames that is different from the first frame. Rather, Muzilla describes averaging the frames in which the focus is shifted and displaying an averaged frame, and Dubberstein describes an ultrasound transducer that transmits a plurality of ultrasound beams in a plurality of transmission directions and frequencies. The averaging of frames in Muzilla is not a description nor a suggestion of interleaving, between P ultrasonic pulse transmissions conducted in a second direction to acquire a first acoustic line signal that belongs to a first frame, at least one ultrasonic pulse transmission for acquiring a second acoustic line signal that belongs to a second frame that is different from the first frame.

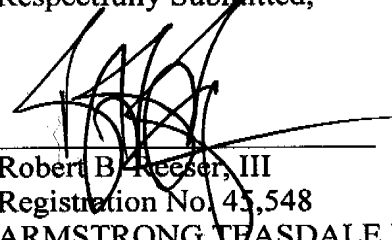
Accordingly, for the reasons set forth above, Claim 7 is submitted to be patentable over Muzilla in view of Dubberstein.

When the recitations of Claim 13 are considered in combination with the recitations of Claim 7, Applicant submits that dependent Claim 13 likewise is patentable over Muzilla in view of Dubberstein.

For at least the reasons set forth above, Applicant respectfully requests that the Section 103 rejection of Claims 5 and 13 be withdrawn.

In view of the foregoing amendment and remarks, all the claims now active in this application are believed to be in condition for allowance. Reconsideration and favorable action is respectfully solicited.

Respectfully Submitted,



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